(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 942 484 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent: 16.05.2001 Bulletin 2001/20

(51) Int Cl.7: H01M 10/40, H01M 10/04

(21) Application number: 99104615.2

(22) Date of filing: 09.03.1999

(54) **Nonaqueous-electrolyte secondary battery**

Sekundärbatterie mit nichtwässerigen Elektrolyten

Batterie secondaire à électrolyte non-aqueux

(84) Designated Contracting States: DE FR GB

(30) Priority: 10.03.1998 JP 5796598

(43) Date of publication of application: 15.09.1999 Bulletin 1999/37

(73) Proprietor: SONY CORPORATION
Tokyo (JP)

(72) Inventor: Yamaguchi, Akira,
c/o Sony Energytec Inc,
Koriyama, Fukushima-ken (JP)

(74) Representative:
MÜLLER & HOFFMANN Patentanwälte
Innere Wiener Strasse 17
81667 München (DE)

(56) References cited:
EP-A- 0 780 920
US-A- 5 360 684
US-A- 5 506 122

- PATENT ABSTRACTS OF JAPAN vol. 017, no. 683 (E-1477), 15 December 1993 & JP 05 234620 A (SONY CORP), 10 September 1993
- PATENT ABSTRACTS OF JAPAN vol. 012, no. 158 (E-608), 13 May 1988 & JP 62 272471 A (TOSHIBA CORP), 26 November 1987

EP 0 942 484 B1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention relates to a nonaqueous-electrolyte secondary battery incorporating a coil electrode formed by laminating elongated positive and negative electrodes through separators such that the outermost layer is the positive electrode.

Related Background Art

[0002] Hitherto, secondary batteries for electronic apparatuses have been nickel-cadmium batteries or lead batteries. The progress of the electronic technique made in recent years has caused the performance of the electronic apparatus to be improved, the size to be reduced and a portable structure to be realized. As a result, a requirement has arisen to raise the energy density of the secondary battery for the electronic apparatus. However, there arises a problem in that the energy density of the nickel-cadmium battery and that of the lead battery cannot satisfactorily be raised because of low discharge voltages.

[0003] In recent years, a nonaqueous-electrolyte secondary battery has energetically been developed and researched as a secondary battery expected to be capable of raising the discharge voltage and realizing small self-discharge and a long lifetime against cycle operations. The nonaqueous-electrolyte secondary battery has been employed in place of the nickel-cadmium battery and the lead battery. The nonaqueous-electrolyte secondary battery incorporates a negative electrode made of a material, such as a carbon material, which permits doping/dedoping lithium ions; and a positive electrode made of a composite lithium oxide, such as composite lithium-cobalt oxide.

[0004] As described above, the nonaqueous-electrolyte secondary battery is required to have satisfactory characteristics including a discharge characteristic under a heavy load and lifetime against a cycle operation. Therefore, the structure of the electrodes of the above-mentioned nonaqueous-electrolyte secondary battery has usually been formed into a coil electrode structure as shown in FIG. 1. As shown in FIG. 1, an elongated positive electrode 103 incorporates positive-electrode-mix layers 102a and 102b formed by applying a positive-electrode mix to each of the two sides of a collector 101. An elongated negative electrode 106 similarly incorporates negative-electrode-mix layers 105a and 105b formed by applying a negative-electrode mix to each of the two sides of a collector 104. The positive and negative electrodes 103 and 106 are wound such that a separator 107 is interposed so that a coil electrode 108 is formed. In the foregoing case, internal short circuit occurring when lithium is deposited during a charging operation must be prevented. Therefore, the width and length of the negative electrode 106 opposite to the positive electrode 103 usually are made to be larger than those of the positive electrode 103.

[0005] The above-mentioned coil electrode 108 incorporates the negative electrode 106 which forms the innermost layer and the outermost layer. Therefore, portions, each containing non-reacted negative-electrode active material which does not concern the charge/discharge, exist adjacent to the end of the outermost layer of the negative electrode 106 and the innermost layer of the same. Therefore, the inside portion of the battery cannot effectively be used. As a result, there arises a problem in that the energy density cannot satisfactorily be raised.

[0006] To solve the above-mentioned problems, a technique has been disclosed in Japanese Patent Laid-Open No. 5-234620. As shown in FIG. 2, an elongated positive electrode 113 incorporates positive-electrode-mix layers 112a and 112b formed by applying a positive-electrode mix to each of the two sides of a collector 111. An elongated negative electrode 116 incorporates negative-electrode-mix layers 115a and 115b formed by applying a negative-electrode-mix to each of the two sides of a collector 114. The positive electrode 113 and the negative electrode 116 are wound such that a separator 117 is interposed so that a coil electrode 118 is formed. The outermost layer electrode, with which charge/discharge of the coil electrode 118 is performed, is made to be the positive electrode 113. Moreover, a portion adjacent to an outermost end 113a of the positive electrode and/or a portion adjacent to an innermost end 113b is formed such that the positive-electrode-mix layer 112a (only the inner positive-electrode-mix layer 112a in the foregoing case) is formed on only either main surface of the collector 111. Thus, the quantity of the non-reacted negative-electrode active material in the battery can be reduced. Thus, the inside portion of the battery is effectively used to raise the energy density correspondingly.

[0007] However, the above-mentioned coil electrode has the structure as shown in FIG. 2 such that the outermost end 116a of the negative electrode 116 is formed by only the collector 114. A negative-electrode lead 119 is provided for the upper surface of the collector 114 so that a projection is formed on the upper surface. Also the positive electrode 113 has an outermost end 113a formed by only the collector 111. If the projection exists as described above, the projection pierces the separator 117 disposed between the negative electrode 116 and the positive electrode 113. Thus, the projection is undesirably brought into contact with the collector 111 of the positive electrode 113. It leads to

a fact that short circuit easily takes place. As a result, a percent defective is raised and, therefore, reliability deteriorates.

SUMMARY OF THE INVENTION

[0008] In view of the foregoing, an object of the present invention is to provide a nonaqueous-electrolyte secondary battery which reduce the quantity of a non-reacted active material for the negative electrode in the battery to effectively use the inside portion of the battery so as to raise the energy density, elongate the lifetime against a cycle operation, prevent a defect and improve the reliability.

[0009] According to one aspect of the present invention, there is provided a nonaqueous-electrolyte secondary battery including: a coil electrode formed by laminating an elongated positive electrode which has a positive-electrode-mix layer formed on at least either of main surfaces of a positive-electrode collector and an elongated negative electrode which has a negative-electrode-mix layer formed on at least either main surfaces of a negative-electrode collector and by winding a formed laminate such that the positive electrode is positioned at the outermost position of the coil electrode, wherein the positive-electrode-mix layer is formed on only either of main surfaces of the collector at the position adjacent to the outermost end of the positive electrode and/or the position adjacent to the innermost end of the positive electrode, the positive-electrode-mix layer is not formed on the positive-electrode collector at the outermost end of the positive electrode and only the positive-electrode collector is formed, the negative-electrode-mix layer is not formed on the negative-electrode collector at the outermost end of the negative electrode and only the negative-electrode collector is formed, and the outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode is, in the direction from the inner portion of the coil electrode toward the outer portion of the coil electrode, positioned more forwards than the outermost end of the positive-electrode collector.

[0010] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the coil electrode incorporates a negative-electrode lead adjacent to an outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode, and the negative-electrode lead is positioned more forwards than the outermost end of the positive-electrode collector positioned at the outermost end of the positive electrode.

[0011] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the coil electrode has a structure that distance L from the outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode to the outermost end of the positive-electrode collector positioned at the outermost end of the positive electrode which are positioned in a fore-and-aft direction from the inner portion of the coil electrode toward the outer portion of the coil electrode satisfies the following relationship on an assumption that the diameter of the coil electrode is d:

$$0 < L \leq \pi d$$

[0012] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the negative-electrode mix contains a negative-electrode material and a binder.

[0013] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the negative-electrode material is at least one type material selected from a group consisting of a crystalline metal oxide and an amorphous metal oxide which permit doping/dedoping lithium ions.

[0014] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the positive-electrode mix contains a positive-electrode material, a conductive material and a binder.

[0015] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the positive-electrode material is at least one type material selected from a group consisting of $LiMO_2$ (where M is at least any one of Co, Ni, Mn, Fe, Al, V and Ti) and interlayer compounds each containing Li.

[0016] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the separator is made of at least one type material selected from a group consisting of polyethylene and polypropylene.

[0017] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the positive-electrode collector is made of at least one type material selected from a group consisting of aluminum, stainless steel and nickel.

[0018] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the negative-electrode collector is made of at least one type material selected from a group consisting of copper, stainless steel and nickel.

[0019] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the nonaqueous-electrolyte secondary battery contains a nonaqueous electrolyte prepared by dissolving an electrolyte in nonaqueous solvent, and the nonaqueous solvent is made of at least one type material selected from a group consisting of propylene carbonate, ethylene carbonate, 1, 2-dimethoxyethane, 1, 2-diethoxyethane, diethylcarbonate,

γ-butyrolactone, tetrahydrofuran, 1,3-dioxolane, 4-methyl-1, 3-dioxolane, diethylether, sulfolane, methylsulfolane, acetonitrile and propionitrile.

[0020] The nonaqueous-electrolyte secondary battery according to the present invention may have a structure that the electrolyte is at least one type material selected from a group consisting of $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiBF_4$, $LiB(C_6H_5)_4$, LiCl, LiBr, $LiSO_3CH_3$ and $LiSO_3CF_3$.

[0021] Other objects, features and advantages of the invention will be evident from the following detailed description of the preferred embodiments described in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 is a cross sectional view showing the structure of a conventional nonaqueous-electrolyte secondary battery;
FIG. 2 is a cross sectional view showing another conventional nonaqueous-electrolyte secondary battery;
FIG. 3 is a cross sectional view showing the structure of a nonaqueous-electrolyte secondary battery according to the present invention;
FIG. 4 is a cross sectional view showing the structure of the nonaqueous-electrolyte secondary battery according to the present invention;
FIG. 5 is a perspective view showing a portion including a positive-electrode collector of the nonaqueous-electrolyte secondary battery according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] An embodiment of the present invention will now be described with reference to the drawings.

[0024] An embodiment of a nonaqueous-electrolyte secondary battery according to the present invention is shown in FIG. 3.

[0025] The nonaqueous-electrolyte secondary battery according to this embodiment, as shown in FIG. 3, incorporates a positive electrode 3 having positive-electrode-mix layers 2a and 2b formed on the two sides of a positive-electrode collector 1. Moreover, a negative electrode 6 incorporates negative-electrode-mix layers 5a and 5b formed on the two sides of the negative-electrode collector 4. The positive electrode 3 and the negative electrode 6 are wound such that a separator 7 is interposed. The separator 7 is a small-pore film made of polypropylene or polyethylene. Thus, a coil electrode is formed. Thus, insulating members 8 are placed on the two vertical surfaces of the coil electrode, followed by accommodating the coil electrode having the insulating members 8 into a battery can 9.

[0026] A battery cover 10 is joined to the battery can 9 by crimping the battery cover 10 through a sealing gasket 11. The battery cover 10 and the battery can 9 are electrically connected to the positive electrode 3 and the negative electrode 6 respectively through a positive-electrode lead 12 and a negative-electrode lead 13. Thus, the positive electrode and the negative electrode of the battery are formed.

[0027] Note that a current-limiting thin plate 14 serving as a safety unit is provided for the battery according to this embodiment. The positive-electrode lead 12 is welded to the current-limiting thin plate 14 so as to electrically be connected to the battery cover 10 through the current-limiting thin plate 14.

[0028] When the pressure in the battery having the above-mentioned structure has been raised, the current-limiting thin plate 14 is pushed upwards and therefore deformed. Thus, the positive-electrode lead 12 is cut such that a portion welded to the current-limiting thin plate 14 is left. As a result, the electric current is limited.

[0029] A cross sectional structure of the nonaqueous-electrolyte secondary battery according to the present invention is shown in FIG. 4. In the nonaqueous-electrolyte secondary battery according to this embodiment, the positive-electrode-mix layer 2a is, as shown in FIG. 4, formed on only either main surface (on the inside) of the positive-electrode collector 1 at a position adjacent to an outermost end 3a of the positive electrode 3 and/or an innermost end 3b of the same. No positive-electrode-mix layer is formed on the positive-electrode collector 1 at the outermost end 3a of the positive electrode 3. Moreover, no negative-electrode-mix layer is formed on the negative-electrode collector 4 at an outermost end 6a of the negative electrode 6. That is, only the negative-electrode collector 4 is formed at the outermost end 6a.

[0030] In a direction from the inner portion of the coil electrode 15 to the outer portion of the same, an outermost end of the negative-electrode collector 4, which is the outermost end 6a of the negative electrode 6, is positioned more forwards than the outermost end of the positive-electrode collector 1 which is the outermost end 3a of the positive electrode 3.

[0031] As described above, the positive-electrode-mix layer 2a is formed on only either main surface of the positive-electrode collector 1 at the position adjacent to the outermost end 3a of the positive electrode 3 and/or the position adjacent to the innermost end 3b of the same. Therefore, the necessity of applying the positive-electrode mix to each

of the two sides of the positive-electrode collector 1 can be eliminated. Therefore, a portion to which the positive-electrode-mix layer 2a is applied must be formed on the main surface of the positive-electrode collector 1, as shown in FIG. 5.

[0032] In the nonaqueous-electrolyte secondary battery according to the present invention, the negative-electrode lead 13 is formed adjacent to the outermost end of the negative-electrode collector 4 which is the outermost end 6a of the negative electrode 6 of the coil electrode 15. In a direction from the inner portion of the coil electrode 15 to the outer portion, the negative-electrode lead 13 is positioned more forwards than the outermost end of the positive-electrode collector 1 which is the outermost end 3a of the positive electrode 3. Note that the nonaqueous-electrolyte secondary battery according to the present invention has a structure that a positive electrode lead (not shown) of the positive electrode 3 is disposed in the inside portion.

[0033] An assumption will now be described which is made about the following distance of a region in the coil electrode 15 of the nonaqueous-electrolyte secondary battery according to the present invention. The distance is a distance in the longitudinal direction from the inner portion of the coil electrode 15 toward the outer portion of the same. The assumption is made that the distance from the outermost end of the negative-electrode collector 4, which is the outermost end 6a of the negative electrode 6, to the outermost end of the positive-electrode collector 1, which is the outermost end 3a of the positive electrode 3, is L. Another assumption is made that the diameter of the coil electrode 15 is d. It is preferable that the relationship $0 < L \leq \pi d$ is satisfied.

[0034] The nonaqueous-electrolyte secondary battery according to the present invention incorporates the coil electrode 15. The coil electrode 15 is formed by laminating the elongated positive electrode 3 and the elongated negative electrode 6 which are laminated through the separator 7 such that the outermost layer is the positive electrode 3. The positive-electrode-mix layer 2a is formed on only either main surface of the positive-electrode collector 1 at the position adjacent to the outermost end 3a of the positive electrode 3 and/or the position adjacent to the innermost end 3b. In addition, no positive-electrode mix is formed on the positive-electrode collector 1 at the outermost end 3a of the positive electrode 3. Only the positive-electrode collector 1 is formed at the outermost end 3a. Moreover, no negative-electrode-mix layer is formed on the negative-electrode collector 4 at the outermost end 6a of the negative electrode 6. Only the negative-electrode collector 4 is formed at the outermost end 6a.

[0035] In the direction from the inner portion of the coil electrode 15 toward the outer portion, the outermost end of the negative-electrode collector 4, which is the outermost end 6a of the negative electrode 6, is positioned more forwards than the outermost end of the positive-electrode collector 1 which is the outermost end 3a of the positive electrode 3. Therefore, the quantity of a non-reactive negative-electrode active material in the battery can be reduced. As a result, an effective area can be enlarged correspondingly in the battery. Thus, the inside portion of the battery can effectively be used, causing the energy density to be raised and the lifetime against a cycle operation to be elongated.

[0036] The nonaqueous-electrolyte secondary battery according to the present invention incorporates the negative-electrode lead 13 formed adjacent to the outermost end of the negative-electrode collector 4 which is the outermost end 6a of the negative electrode 6. In the direction from the inner portion of the coil electrode 15 toward the outer portion of the same, the negative-electrode lead 13 is positioned more forwards than the outermost end of the positive-electrode collector 1 which is the outermost end 3a of the positive electrode 3. Therefore, even if the negative-electrode lead 13 pierces the separator 7 disposed between the coil electrode 15 and the battery can 9, the negative-electrode lead 13 is brought into contact with only the battery can 9 which is also the negative electrode. As a result, any internal short circuit occurs, no defect takes place and, therefore, the reliability can be improved.

[0037] In the coil electrode 15 of the nonaqueous-electrolyte secondary battery according to the present invention, the outermost end of the negative-electrode collector 4, which is the outermost end 6a of the negative electrode 6, and the outermost end of the positive-electrode collector 1, which is the outermost end 3a of the positive electrode 3, are positioned in the fore-and-aft direction from the inner portion of the coil electrode 15 toward the outer portion of the same. An assumption is made that the distance from the outermost end of the negative-electrode collector 4 to the outermost end of the positive-electrode collector 1 is L. Another assumption is made that the diameter of the coil electrode 15 is d. In this case, it is preferable that the relationship $0 < L \leq \pi d$ is satisfied. If the foregoing structure is employed, no internal short circuit occurs, the energy density is furthermore raised and the lifetime against a cycle operation can furthermore be elongated.

[0038] A state will now be considered that the distance L from the outermost end of the negative-electrode collector 4, which is the outermost end 6a of the negative electrode 6, to the outermost end of the positive-electrode collector 1, which is the outermost end 3a of the positive electrode 3, is shorter than the above-mentioned range. In the foregoing case, the outermost end of the positive-electrode collector 1 overlaps the outermost end of the negative-electrode collector 4.

[0039] Therefore, the percent defective is raised though the energy density is not lowered. If the distance L is longer than the above-mentioned range, many portions are produced in which the negative electrode 6 and the positive electrode 3 are not opposite to each other. Therefore, the energy density is undesirably lowered though the percentage defective is not lowered.

[0040] The positive electrode 3 and the negative electrode 6 according to the present invention have the above-mentioned structures. The mix layers and collectors for constituting the positive electrode 3 and the negative electrode 6 may be known materials.

[0041] The positive-electrode-mix layers 2a and 2b contain a positive-electrode material, which permits lithium ions to be doped/dedoped, a conductive material and a binder.

[0042] It is preferable that the positive-electrode material contains Li in a sufficiently large quantity. For example, it is preferable that to employ a composite metal oxide expressed by $LiMO_2$ (where M is at least one type of a material selected from a group consisting of Co, Ni, Mn, Fe, Al, V and Ti) and composed of Li and a transition metal, or an interlayer compound containing Li.

[0043] The conductive material for imparting conductivity to the positive electrode and the binder for causing the positive-electrode material to be held by the positive-electrode collector may be known materials.

[0044] The conductive material may be graphite or carbon black, while the binder may be fluorine resin, such as polyvinylidene fluoride.

[0045] The negative-electrode-mix layers 5a and 5b contain the negative-electrode material which permits lithium ions to be doped/dedoped and a binder.

[0046] The negative-electrode material may be a carbon material. The carbon material is exemplified by pyrocarbon, coke (pitch coke, needle coke and petroleum coke), graphite, vitreous carbon, a calcinated organic polymer compound (a material obtained by calcinating phenol resin, furan resin or the like), carbon fiber and active carbon. The negative-electrode material may be crystalline metal oxide or amorphous metal oxide which permits lithium ions to be doped/dedoped, as well as the foregoing carbon material.

[0047] The binder for causing the negative-electrode material to be held by the negative-electrode collector may be a known material. For example, the binder may be fluorine resin, such as polyvinylidene fluoride.

[0048] The battery according to the present invention contains a known nonaqueous electrolyte in which an electrolyte is dissolved in nonaqueous solvent, such as organic solvent.

[0049] The organic solvent is not limited particularly. The organic solvent is exemplified by propylene carbonate, ethylene carbonate, 1, 2-dimethoxyethane 1, 2-dimethoxyethane, 1, 2-diethoxyethane, diethyl carbonate, γ-butyrolactone, tetrahydrofuran, 1,3-dioxolane, 4-methyl-1, 3-dioxolane, diethylether, sulfolane, methylsulfolane, acetonitrile and propionitrile. Any one of the foregoing material may be employed or a mixture of the same may be employed as mixed solvent.

[0050] The electrolyte is not limited particularly. The electrolyte is exemplified by $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiBF_4$, $LiB(C_6H_5)_4$, LiCl, LiBr, $LiSO_3CH_3$ and $LiSO_3CF_3$.

[0051] The material of the separator 7 is not limited particularly. The material is exemplified by woven fabric, unwoven fabric or small-pore film made of synthetic resin. In particular, the small-pore film made of synthetic resin is a preferred material. Moreover, a polyolefine small-pore film is a preferred material in viewpoints of realizing a required thickness, strength of the formed film and resistance of the film. Specifically, the following materials may be employed: a small-pore film made of polyethylene or polypropylene or a small-pore film made of a mixture of the foregoing materials.

[0052] The shape of the collector of the electrode is not limited particularly. A foil structure, a mesh structure or a net structure made of expand metal may be employed. It is preferable that the positive-electrode collector 1 is made of, for example, aluminum, stainless steel or nickel. It is preferable that the negative-electrode collector 4 is made of, for example, copper, stainless steel or nickel.

[0053] The battery can 8 may be made of iron, nickel, stainless steel or aluminum. If electrochemical corrosion occurs in the nonaqueous electrolyte containing the above-mentioned material during the operation of the battery, plating may be performed.

Examples

[0054] Examples of the present invention will now be described with results of experiments.

<Manufacturing of Samples>

Sample 1

[0055] Initially, the negative electrode was manufactured as follows.

[0056] Petroleum pitch was employed as a starting material, followed by calcinating the petroleum pitch so that coarse pitch coke was obtained. The coarse pitch coke was pulverized so that powder having an average particle size of 40 μm was obtained. Then, the obtained powder was calcinated in an inactive gas at 1000°C to remove impurities. Thus, coke powder was obtained.

[0057] Then, 90 parts by weight of thus-obtained coke powder, serving as a carrier for negative-electrode active

material, and 10 parts by weight of polyvinylidene fluoride (PVDF) serving as a binder were mixed. Thus, a negative-electrode mix was prepared, followed by dispersing the negative-electrode mix in N-methylpyrolidone which serves as solvent. As a result, negative-electrode mix slurry was obtained. The negative-electrode mix slurry was applied to the two sides of a negative-electrode collector in the form of copper foil having a thickness of 10 μm. Then, the applied solvent was dried. The negative-electrode collector was compression-molded with a roller pressing machine. As a result, an elongated negative electrode was obtained which had a width of 41.5 mm and a length of 250 mm. The thickness of the negative-electrode-mix layer on each side of the negative-electrode collector was 105 μm. The negative-electrode-mix layer was not formed on the negative-electrode collector of the negative electrode at the outermost end. A portion formed by only the negative-electrode collector was created.

[0058] On the other hand, the positive electrode was manufactured as follows.

[0059] That is, 0.05 mole of lithium carbonate and 1 mole of cobalt carbonate were mixed with each other, and then the mix was calcinated at 900°C in air for 5 hours. Thus, $LiCoO_2$ was obtained.

[0060] Then, obtained $LiCoO_2$ was used as a positive-electrode active material such that 91 parts by weight of $LiCoO_2$, 6 parts by weight of graphite serving as a conductive material and 3 parts by weight of polyvinylidene fluoride (PVDF) serving as a binder were mixed with each other. Thus; a positive-electrode mix was prepared. Then, the obtained positive-electrode mix was dispersed in N-methylpyrolidone so that positive-electrode mix slurry was obtained. The positive-electrode mix slurry was applied to a region of only either side of a positive-electrode collector made of elongated aluminum foil having a thickness of 20 μm, the region having a length of 247 mm. Then, the positive-electrode mix slurry was dried. Then, positive-electrode mix slurry was applied to the other main surface of the positive-electrode collector in a region having a length of 167 mm such that a position at which the application was started was made coincide with the above-mentioned positive-electrode mix slurry. Then, the positive-electrode mix slurry was dried, followed by compressing the two sides of the positive-electrode collector with a roll to compression-mold the positive-electrode collector. Thus, an elongated positive electrode was obtained which had a width of 39.5 mm. The positive electrode incorporated a portion having two sides on each of which the positive-electrode-mix layer was formed, the portion having a length of 167 mm. A portion of the positive electrode, on either side of which the positive-electrode-mix layer was formed, had a length of 80 mm. The thickness of each of the positive-electrode-mix layers was 80 μm. The positive electrode had the outermost end and the innermost end each incorporating a portion in which the positive-electrode-mix layer was not formed and in which only the positive-electrode collector was formed.

[0061] The thus-manufactured elongated positive electrode and the negative electrode and two separators, each of which had a thickness of 25 μm and a width of 44 mm and which were in the form of small-pore polypropylene films, were laminated. The laminate had four layers formed by sequentially laminating the negative electrode, the separator, the positive electrode and the separator in this sequential order. The laminate was lengthwise wound plural times. Thus, a spiral shape was formed which had a structure that the portion in which only either side of the positive-electrode collector had the positive-electrode-mix layer was first wound and the negative electrode was placed inside. The end of the outermost separator was secured with a tape. Thus, a coil electrode was manufactured. The negative electrode of the coil electrode was longer than the positive electrode of the same. Therefore, in the direction from the inner portion of the coil electrode toward the outer portion, the outermost end of the negative electrode collector which was the outermost end of the negative electrode was, as a matter of course, positioned more forwards than the outermost end of the positive electrode collector which was the outermost end of the positive electrode.

[0062] The outer diameter of the coil collector was 13 mm, while the inner diameter of a hollow portion formed in the central portion of the coil collector was 3.5 mm. The outermost end of the negative-electrode collector which was the outermost end of the negative electrode and the outermost end of the positive-electrode collector which was the outermost end of the positive electrode were positioned apart from each other in the fore-and-aft direction for distance L which was 35 mm.

[0063] In this embodiment, the negative-electrode lead was positioned at the outermost end of the negative electrode, while the positive-electrode lead was positioned at the innermost end of the positive electrode.

[0064] The thus-manufactured coil electrode was accommodated in an iron battery can applied with nickel plating. An insulating plate was placed on each of the upper and lower sides of the coil electrode. The positive-electrode lead was connected to the battery cover by welding, while the negative-electrode lead was connected to the battery can by welding.

[0065] Then, a nonaqueous electrolyte was prepared by dissolving, at a concentration of 1 mole/liter, $LiPF_6$ in a mixed solvent which contained propylene carbonate and diethyl carbonate in the same quantities. Then, 3.0 g of the nonaqueous electrolyte was injected into the battery can so as to be impregnated into the coil electrode. Then, the battery can was crimped through an insulating sealing gasket applied with asphalt so that the battery cover was secured. Thus, the hermeticity in the battery was maintained.

[0066] Thus, a cylindrical nonaqueous-electrolyte secondary battery (having a diameter of 14 mm and a height of 50 mm) was manufactured. The foregoing cylindrical nonaqueous-electrolyte secondary battery was called Sample 1 for convenience.

Samples 2, 3, 4 to 6, 11 and 12

[0087] Cylindrical nonaqueous-electrolyte secondary batteries were manufactured by a method similar to that for manufacturing Sample 1 except for a structure in which the distance from the outermost end of the negative electrode to the outermost end of the positive electrode which was varied as shown in Table 1. The foregoing secondary batteries were called Samples 4 to 6, 11 and 12. To perform comparisons, cylindrical nonaqueous-electrolyte secondary batteries were manufactured by a method similar to that for manufacturing Sample 1. In this case, as shown in Table 1, the cylindrical nonaqueous-electrolyte secondary batteries were different from Sample 1 as follows: the distance from the outermost end of the negative electrode and the outermost end of the positive electrode was - 2 mm; the positive-electrode collector overlapped the negative-electrode collector in the outermost portion; the distance from the outermost end of the negative electrode to the outermost end of the positive electrode was 0 mm; and the end of the negative-electrode collector and the end of the positive-electrode collector coincided with each other in the outermost portion. The foregoing comparative samples were called Samples 2 and 3 for convenience. Samples 4 to 6, 11, 12, 2 and 3 were structured such that the outer diameter of the coil electrode was made to be 13 mm by adjusting the lengths of the positive-electrode-mix layers formed on the two sides of the positive electrode and the lengths of the negative-electrode-mix layers formed on the two sides of the negative electrode.

Table 1

	Length of Positive-Electrode-Mix Layer Formed on Either Side of Positive Electrode at Innermost End of Positive Electrode (mm)	Length of Positive-Electrode-Mix Layer Formed on Either Side of Positive Electrode at Outermost End of Positive Electrode (mm)	Length of Positive-Electrode -Mix Layers Formed on Two Sides of Positive Electrode (mm)
Sample 1	80	0	167
Sample 2	80	0	167
Sample 3	80	0	167
Sample 4	60	0	182
Sample 5	40	0	197
Sample 6	20	0	201
Sample 7	0	5	205
Sample 8	0	15	202
Sample 9	0	50	176

Sample 10	40	10	194
Sample 11	60	0	179
Sample 12	60	0	177
Sample 13	60	0	176
Sample 14	395	–	0
Sample 15	395	–	0

	Length of Negative-Electrode -Mix Layers Formed on Two Sides of Negative Electrode (mm)	Length of Negative-Electrode -Mix Layers Formed on Either Side of Negative Electrode (mm)	Distance from Outermost End of Negative Electrode to Outermost End of Positive Electrode (mm)
Sample 1	250	0	35
Sample 2	250	0	-2
Sample 3	250	0	0
Sample 4	245	0	15
Sample 5	240	0	10
Sample 6	224	0	17
Sample 7	213	0	33
Sample 8	220	0	35
Sample 9	229	0	50
Sample 10	247	0	5
Sample 11	243	0	27
Sample 12	241	0	38

Sample 13	239	0	43
Sample 14	0	398	35
Sample 15	0	398	0

	Energy Density Ratio (%)	Percent Defective (%)
Sample 1	100.0	3
Sample 2	100.0	20
Sample 3	100.0	18
Sample 4	102.4	3
Sample 5	104.8	1
Sample 6	101.9	1
Sample 7	100.2	2
Sample 8	101.2	2
Sample 9	97.1	1
Sample 10	105.8	6
Sample 11	101.0	1
Sample 12	100.0	2
Sample 13	99.5	3
Sample 14	95.0	2
Sample 15	95.0	20

Samples 7 to 9

[0068] Processes similar to that for manufacturing Sample 1 were performed except for structures in which the positive-electrode-mix layer was formed on only either side adjacent to the innermost end of the positive electrode. Moreover, the distance from the outermost end of the negative electrode to the outermost end of the positive electrode was varied as shown in Table 1. Thus, cylindrical nonaqueous-electrolyte secondary batteries were manufactured. The thus-manufactured cylindrical nonaqueous-electrolyte secondary batteries were called Samples 7 to 9 for convenience. Samples 7 to 9 were structured such that the outer diameter of the coil electrode was made to be 13 mm by adjusting the lengths of the positive-electrode-mix layers formed on the two sides of the positive electrode and the lengths of the negative-electrode-mix layers formed on the two sides of the negative electrode.

Sample 10

[0069] A cylindrical nonaqueous-electrolyte secondary battery was manufactured by a method similar to that for

manufacturing Sample 1 except for structures in which the positive-electrode-mix layer was formed on only either side at positions adjacent to the innermost and outermost ends of the positive electrode. Moreover, the distance from the outermost end of the negative electrode to the outermost end of the positive electrode was varied as shown in Table 1. The thus-manufactured cylindrical nonaqueous-electrolyte secondary battery was called Sample 10 for convenience. Sample 10 was structured such that the outer diameter of the coil electrode was made to be 13 mm by adjusting the lengths of the positive-electrode-mix layers formed on the two sides of the positive electrode.

Sample 14 and 15

[0070] Cylindrical nonaqueous-electrolyte secondary batteries were manufactured by a method similar to that for manufacturing Sample 1 except for structures in which the positive-electrode-mix layer was formed on the overall length of only either side of the positive electrode and the negative electrode. Moreover, the distance from the outermost end of the negative electrode to the outermost end of the positive electrode was varied as shown in Table 1. The thus-manufactured cylindrical nonaqueous-electrolyte secondary batteries were called Samples 14 and 15 for convenience. Sample 14 and 15 were structured such that the outer diameter of the coil electrode was made to be 13 mm by adjusting the lengths of the positive-electrode-mix layers formed on the two sides of the positive electrode.

<Evaluation of Samples>

[0071] Each of samples 1 to 15 was charged for 8 hours at a charging voltage of 4.20 V with a charging current of 300 mA, and then the foregoing samples were, with a load of 600 mA, discharged to 2.75 V. Thus, the energy densities were measured. Assuming that the result of Sample 9 was 100, the energy densities of the sample batteries with respect to 100 were obtained. Also results were shown in Table 1. Moreover, a percentage defective of each battery was obtained and also results were shown in Table 1.

[0072] Comparisons were performed by using results shown in Table 1 among Samples 2, 3 and 15 and samples 1, 4 to 14 according to the present invention. Samples 2, 3 and 15 were structured such that the distance from the outermost end of the negative electrode to the outermost end of the positive electrode was - 2 mm. Therefore, the positive-electrode collector overlapped the negative-electrode collector in the outermost portion. As an alternative to this, the distance from the outermost end of the negative electrode to the outermost end of the positive electrode was 0 mm. Therefore, the end of the negative-electrode collector and the end of the positive-electrode collector coincided with each other in the outermost portion. Samples 1, 4 to 14 according to the present invention were manufactured such that the outermost end of the negative-electrode collector which was the outermost end of the negative electrode was, in a direction from the inner portion of the coil electrode toward the outer portion of the same; positioned more forwards than the outermost end of the positive-electrode collector which was the outermost end of the positive electrode. As a result of the comparisons, the samples according to the present invention enabled the percentage defective to considerably be reduced without reduction in the energy density.

[0073] Samples 1 and 4 to 14 according to the present invention were structured such that the outermost end of the negative-electrode collector which was the outermost end of the negative electrode was, in a direction from the inner portion of the coil electrode toward the outer portion of the same, positioned more forwards than the outermost end of the positive-electrode collector which was the outermost end of the positive electrode. Samples 1, 4 to 8 and 10 to 14 among the foregoing samples 1 and 4 to 14 were structured such that the distance L from the outermost end of the negative-electrode collector which was the outermost end of the negative electrode to the outermost end of the positive-electrode collector which was the outermost end of the positive electrode satisfied $0 < L \leq xd$ on an assumption that the diameter of the coil electrode was d. Sample 9 did not satisfy the above-mentioned relationship. When the foregoing samples were compared with one another, Sample 9 encountered somewhat reduction in the energy density.

[0074] Samples 14 and 15, having the electrode mix layer formed on only either side of each of the collectors of both of the positive electrode and the negative electrode, were subjected to a comparison. When the electrode mix layer was formed on only either side of the collector, Sample 14 according to the present invention enabled the percentage defective to considerably be reduced without reduction in the energy density. On the other hand, Sample 15 to which the present invention is not applied encountered a high percentage defective.

[0075] As can be understood from the above-mentioned results, the structure of the present invention in which the elongated positive and negative electrodes were laminated through separators, followed by winding a laminate such that the positive electrode forms the outermost layer so that a coil electrode is formed. Moreover, the positive-electrode-mix layer is formed on only either main surface of the collector at a position adjacent to the outermost end of the positive electrode and/or a position adjacent to the innermost end. At the outermost end of the positive electrode, the positive-electrode-mix layer is not formed on the positive-electrode collector, that is, only the positive-electrode collector is formed. At the outermost end of the negative electrode, the negative-electrode collector is not formed on the negative-electrode collector, that is, only the negative-electrode collector is formed. In the direction from the inner portion of the

coil electrode toward the outer portion of the same, the outermost end of the negative-electrode collector, which is the outermost end of the negative electrode, is positioned more forwards than the outermost end of the positive-electrode collector which is the outermost end of the positive electrode. Thus, non-reacted active material for the negative electrode in the battery can be reduced. Thus, an effective area can be enlarged in the battery correspondingly. Therefore, the inside portion of the battery can effectively be used, causing the energy density to be raised. Thus, elongation of lifetime against cycle operations was confirmed.

[0076] In the present invention, the negative-electrode lead is formed adjacent to the outermost end of the negative-electrode collector which is the outermost end of the negative electrode. In the direction from the inner portion of the coil electrode toward the outer portion of the same, the negative-electrode lead is positioned more forwards than the outermost end of the positive-electrode collector which is the outermost end of the positive electrode. Thus, even if the negative-electrode lead pierces the separator disposed between the coil electrode and the battery can, the negative-electrode lead is brought into contact with only the battery can which is the same negative electrode. Therefore, internal short circuit does not take place and, therefore, any defect occurs. Thus, the reliability can be improved.

[0077] In the present invention, the outermost end of the negative-electrode collector, which is the outermost end of the negative electrode, and the outermost end of the positive-electrode collector, which is the outermost end of the positive electrode, are positioned fore-and-aft in the distance from the inner portion of the coil electrode toward the outer portion of the same. Assuming that the distance from the outermost end of the negative-electrode collector to the outermost end of the positive-electrode collector is L and the diameter of the coil electrode is d, the relationship $0 < L \leq \pi d$ is satisfied. Thus, the energy density can furthermore be raised and the lifetime against the cycle operation can furthermore be elongated.

[0078] The diameter of the cylindrical nonaqueous-electrolyte secondary battery was varied to 18 mm and 20 mm to evaluate each of the manufactured cylindrical nonaqueous-electrolyte secondary batteries. Thus, similar tendencies to those shown with the above-mentioned samples were shown.

[0079] An elliptical coil electrode was manufactured as the coil electrode so that a nonaqueous-electrolyte secondary battery which was a rectangular battery having a thickness of 9 mm, a width of 34 mm and a height of 48 mm was manufactured so as to be evaluated. The outermost end of the negative-electrode collector which was the outermost end of the negative electrode was positioned more forwards than the outermost end of the positive-electrode collector which was the outermost end of the positive electrode. The distance from the outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode to the outermost end of the positive-electrode collector positioned at the outermost end of the positive electrode which were positioned fore-and-aft was not longer than the circumference. In this case, reduction of the percentage defective was enabled without reduction in the energy density.

[0080] As described above, the nonaqueous-electrolyte secondary battery according to the present invention incorporates: a coil electrode formed by laminating an elongated positive electrode and an elongated negative electrode through a separator and by winding a formed laminate such that the positive electrode is positioned at the outermost position, wherein the positive-electrode-mix layer is formed on only either main surface of the collector at the position adjacent to the outermost end of the positive electrode and/or the position adjacent to the innermost end, the positive-electrode-mix layer is not formed on the positive-electrode collector at the outermost end of the positive electrode and only the positive-electrode collector is formed, the negative-electrode-mix layer is not formed on the negative-electrode collector at the outermost end of the negative electrode and only the negative-electrode collector is formed, and the outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode is, in the direction from the inner portion of the coil electrode toward the outer portion of the same, positioned more forwards than the outermost end of the positive-electrode collector. Therefore, the non-reacted active material for the negative electrode in the battery can be reduced. Thus, the effective battery area can be enlarged correspondingly. Therefore, the inside portion of the battery can effectively be used, causing the energy density to be raised and the lifetime against a cycle operation to be elongated.

[0081] The nonaqueous-electrolyte secondary battery according to the present invention incorporates the negative-electrode lead formed adjacent to the outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode and the negative-electrode collector is, in the direction from the inner portion of the coil electrode toward the outer portion of the same, positioned more forwards than the outermost end of the positive-electrode collector. Thus, even if the negative-electrode lead pierces the separator disposed between the coil electrode and the battery can, the negative-electrode lead is brought into contact with only the battery can which is also the negative electrode. Therefore, internal short circuit can be prevented, any defect can be prevented, and the reliability can be improved.

[0082] The coil electrode of the nonaqueous-electrolyte secondary battery according to the present invention is structured such that the distance L from the outermost end of the negative-electrode collector positioned at the outermost end of the negative electrode to the outermost end of the positive-electrode collector positioned at the outermost end of the positive electrode which are positioned fore-and-aft in the direction from the inner portion of the coil electrode

toward the outer portion of the same satisfies $0 < L \leq \pi d$ on an assumption that the diameter of the coil electrode is d. Thus, internal short circuit can be prevented, the energy density can furthermore be raised and the lifetime against a cycle operation can furthermore be elongated.

[0083] Although the invention has been described in its preferred form and structure with a certain degree of particularity, it is understood that the present disclosure of the preferred form can be changed in the details of construction and in the combination and arrangement of parts without departing from the scope of the invention as hereinafter claimed.

Claims

1. A nonaqueous-electrolyte secondary battery comprising:

a coil electrode formed by laminating an elongated positive electrode which has a positive-electrode-mix layer formed on at least either of main surfaces of a positive-electrode collector and an elongated negative electrode which has a negative-electrode-mix layer formed on at least either main surfaces of a negative-electrode collector and by winding a formed laminate such that said positive electrode is positioned at the outermost position of said coil electrode, wherein

said positive-electrode-mix layer is formed on only either of main surfaces of said collector at the position adjacent to the outermost end of said positive electrode and/or the position adjacent to the innermost end of said positive electrode, said positive-electrode-mix layer is not formed on said positive-electrode collector at the outermost end of said positive electrode and only said positive-electrode collector is formed,

said negative-electrode-mix layer is not formed on said negative-electrode collector at the outermost end of said negative electrode and only said negative-electrode collector is formed, and

the outermost end of said negative-electrode collector positioned at the outermost end of said negative electrode is, in the direction from the inner portion of said coil electrode toward the outer portion of said coil electrode, positioned more forwards than the outermost end of said positive-electrode collector.

2. A nonaqueous-electrolyte secondary battery according to claim 1, wherein

said coil electrode incorporates a negative-electrode lead adjacent to an outermost end of said negative-electrode collector positioned at the outermost end of said negative electrode, and

said negative-electrode lead is positioned more forwards than the outermost end of said positive-electrode collector positioned at the outermost end of said positive electrode.

3. A nonaqueous-electrolyte secondary battery according to claim 1, wherein

said coil electrode has a structure that distance L from the outermost end of said negative-electrode collector positioned at the outermost end of said negative electrode to the outermost end of said positive-electrode collector positioned at the outermost end of said positive electrode which are positioned in a fore-and-aft direction from the inner portion of said coil electrode toward the outer portion of said coil electrode satisfies the following relationship on an assumption that the diameter of the coil electrode is d:

$$0 < L \leq \pi d$$

4. A nonaqueous-electrolyte secondary battery according to claim 1, wherein

said negative-electrode mix contains a negative-electrode material and a binder.

5. A nonaqueous-electrolyte secondary battery according to claim 4, wherein

said negative-electrode material is at least one type material selected from a group consisting of a crystalline metal oxide and an amorphous metal oxide which permit doping/dedoping lithium ions.

6. A nonaqueous-electrolyte secondary battery according to claim 1, wherein said positive-electrode mix contains a positive-electrode material, a conductive material and a binder.

7. A nonaqueous-electrolyte secondary battery according to claim 6, wherein

said positive-electrode material is at least one type material selected from a group consisting of $LiMO_2$ (where M is at least any one of Co, Ni, Mn, Fe, Al, V and Ti) and intralayer compounds each containing Li.

8. A nonaqueous-electrolyte secondary battery according to claim 1, wherein
said separator is made of at least one type material selected from a group consisting of polyethylene and polypropylene.

9. A nonaqueous-electrolyte secondary battery according to claim 1, wherein
said positive-electrode collector is made of at least one type material selected from a group consisting of aluminum, stainless steel and nickel.

10. A nonaqueous-electrolyte secondary battery according to claim 1, wherein
said negative-electrode collector is made of at least one type material selected from a group consisting of copper, stainless steel and nickel.

11. A nonaqueous-electrolyte secondary battery according to claim 1, wherein

said nonaqueous-electrolyte secondary battery contains a nonaqueous electrolyte prepared by dissolving an electrolyte in nonaqueous solvent, and
said nonaqueous solvent is made of at least one type material selected from a group consisting of propylene carbonate, ethylene carbonate, 1, 2-dimethoxyethane, 1, 2-diethoxyethane, diethylcarbonate, γ-butyrolactone, tetrahydrofuran, 1,3-dioxolane, 4-methyl-1, 3-dioxolane, diethylether, sulfolane, methylsulfolane, acetonitrile and propionitrile.

12. A nonaqueous-electrolyte secondary battery according to claim 11, wherein
said electrolyte is at least one type material selected from a group consisting of $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiBF_4$, $LiB(C_6H_5)_4$, LiCl, LiBr, $LiSO_3CH_3$ and $LiSO_3CF_3$

Patentansprüche

1. Sekundärbatterie mit nicht-wässrigem Elektrolyten, umfassend:

einen Elektrodenwickel erhalten durch Laminieren einer längserstreckten positiven Elektrode, bei der auf zumindest einer der Hauptflächen eines positiven Elektrodenkollektors eine Schicht einer positiven Elektrodenmischung aufgetragen ist, und einer längserstreckten negativen Elektrode, bei der auf zumindest einer der Hauptflächen eines negativen Elektrodenkollektors eine negative Elektrodenmischung aufgetragen ist, wobei das Laminat in der Weise gewickelt ist, dass die positive Elektrode an der äußeren Seite des Elektrodenwickels liegt, wobei
die Schicht der positiven Elektrodenmischung nur an einer Stelle, die an das äußere Ende der positiven Elektrode angrenzt und/oder an einer Stelle, die an das innere Ende der positiven Elektrode angrenzt, auf eine der Hauptflächen des Kollektors aufgetragen ist, und auf dem äußeren Ende der positiven Elektrode die Schicht der positiven Elektrodenmischung nicht auf den positiven Elektrodenkollektor aufgetragen ist, also nur der Kollektor der positiven Elektrode vorliegt,
am äußeren Ende der negativen Elektrode die Schicht aus der negativen Elektrodenmischung nicht auf den Kollektor der negativen Elektrode aufgetragen ist, also nur der Kollektor der negativen Elektrode vorliegt, und wobei in Richtung vom inneren Abschnitt der gewickelten Elektrode zum äußeren Abschnitt der gewickelten Elektrode gesehen das am äußeren Ende der negativen Elektrode liegende äußere Ende des negativen Elektrodenkollektors weiter vorne angeordnet ist als das äußere Ende des Kollektors der positiven Elektrode.

2. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei

der Elektrodenwickel einen Anschluss für die negative Elektrode aufweist, der an das äußere Ende des am äußeren Ende der negativen Elektrode liegenden negativen Elektrodenkollektors anschließt, und
der Anschluss der negativen Elektrode weiter vorne liegt als das äußere Ende des am äußeren Ende der positiven Elektrode liegenden positiven Elektrodenkollektors.

3. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei
der Elektrodenwickel so gestaltet ist, dass ein Abstand L zwischen dem äußeren Ende des am äußeren Ende der negativen Elektrode angeordneten negativen Elektrodenkollektors und dem äußeren Ende des am äußeren Ende der positiven Elektrode angeordneten positiven Elektrodenkollektors, wobei diese in Längsrichtung

von dem inneren Abschnitt des Elektrodenwickels zum äußeren Abschnitt des Elektrodenwickels hintereinander angeordnet sind, die folgende Beziehung erfüllt, unter der Annahme, dass der Durchmesser des Elektrodenwickels d entspricht:

$$0 < L \leq \pi d.$$

4. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei die negative Elektrodenmischung ein Material für die negative Elektrode und ein Bindemittel umfasst.

5. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 4, wobei das Material der negativen Elektrode zumindest eine Art von Material ist, das ausgewählt ist aus einer Gruppe, welche besteht aus einem kristallinen Metalloxid und einem amorphen Metalloxid, welche das Dotieren und Dedotieren von Lithiumionen ermöglichen.

6. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei die positive Elektrodenmischung ein Material für die positive Elektrode, ein leitfähiges Material und ein Bindemittel umfasst.

7. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 6, wobei das positive Elektrodenmaterial zumindest eine Art von Material umfasst, das ausgewählt ist aus einer Gruppe, welche aus $LiMO_2$ (wobei M zumindest eines ist von Co, Ni, Mn, Fe, Al, V und Ti) und Einlagerungsverbindungen besteht, welche jeweils Li enthalten.

8. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei der Separator aus zumindest einem der Materialien hergestellt ist, welche ausgewählt sind aus einer Gruppe, bestehend aus Polyäthylen und Polypropylen.

9. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei der positive Elektrodenkollektor aus zumindest einem der Materialien hergestellt ist, die ausgewählt sind aus einer Gruppe, bestehend aus Aluminium, rostfreiem Stahl und Nickel.

10. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei der negative Elektrodenkollektor aus zumindest einem der Materialien hergestellt ist, die ausgewählt sind aus einer Gruppe, bestehend aus Kupfer, rostfreiem Stahl und Nickel.

11. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 1, wobei

diese einen nicht-wässrigen Elektrolyten enthält, der hergestellt ist durch Lösen eines Elektrolyten in einem nicht-wässrigen Lösungsmittel, und

das nicht-wässrige Lösungsmittel zumindest aus einem der Materialien hergestellt ist, welche ausgewählt sind aus einer Gruppe, bestehend aus Propylencarbonat, Ethylencarbonat, 1,2-Dimethoxyethan, 1,2-Diethoxyethan, Diethylcarbonat, γ-Butyrolacton, Tetrahydrofuran, 1,3-Dioxolan, 4-Methyl-1,3-dioxolan, Diethylether, Sulfolan, Methylsulfolan, Acetonitril und Propionitril.

12. Sekundärbatterie mit nicht-wässrigem Elektrolyten nach Anspruch 11, wobei der Elektrolyt zumindest eines der Materialien ist, die ausgewählt sind aus einer Gruppe, bestehend aus $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiBF_4$, $LiB(C_6H_5)_4$, LiCl, LiBr, $LiSO_3CH_3$ und $LiSO_3CF_3$.

Revendications

1. Accumulateur secondaire à électrolyte non aqueux comprenant :

une électrode en bobine formée en stratifiant une électrode positive allongée qui présente une couche de mélange d'électrode positive formée sur au moins l'une des surfaces principales d'un collecteur d'électrode positive et une électrode négative allongée qui présente une couche de mélange d'électrode négative formée sur au moins l'une des surfaces principales d'un collecteur d'électrode négative et en enroulant un stratifié formé de telle sorte que ladite électrode positive est disposée sur la position extérieure de ladite électrode en

bobine, dans lequel
ladite couche de mélange d'électrode positive est formée sur uniquement l'une des surfaces principales dudit collecteur à la position adjacente de l'extrémité extérieure de ladite électrode positive et/ou à la position adjacente de l'extrémité intérieure de ladite électrode positive, ladite couche de mélange d'électrode positive n'est pas formée sur ledit collecteur d'électrode positive à l'extrémité extérieure de ladite électrode positive et seul ledit collecteur d'électrode positive est formé,
ladite couche de mélange d'électrode négative n'est pas formée sur ledit collecteur d'électrode négative à l'extrémité extérieure de ladite électrode négative et seul ledit collecteur d'électrode négative est formé, et
l'extrémité extérieure dudit collecteur d'électrode négative disposée à l'extrémité extérieure de ladite électrode négative se trouve, dans la direction allant de la partie interne de ladite électrode en bobine vers la partie externe de ladite électrode en bobine, disposé plus en avant que l'extrémité extérieure dudit collecteur d'électrode positive.

2. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel

ladite électrode en bobine incorpore un conducteur d'électrode négative adjacent à une extrémité extérieure dudit collecteur d'électrode négative disposé à l'extrémité extérieure de ladite électrode négative, et
ledit conducteur d'électrode négative est disposé plus en avant de l'extrémité extérieure dudit collecteur d'électrode positive disposé à l'extrémité extérieure de ladite électrode positive.

3. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel
ladite électrode en bobine présente une structure telle que la distance L de l'extrémité extérieure dudit collecteur d'électrode négative disposé à l'extrémité extérieure de ladite électrode négative jusqu'à l'extrémité extérieure dudit collecteur d'électrode positive disposé à l'extrémité extérieure de ladite électrode positive qui sont disposés dans une direction longitudinale allant de la partie interne de ladite électrode en bobine vers la partie externe de ladite électrode en bobine satisfait la relation suivante en supposant que le diamètre de l'électrode en bobine est d:

$$0 < L \leq \pi d$$

4. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel
ledit mélange d'électrode négative contient un matériau d'électrode négative et un liant.

5. Accumulateur secondaire à électrolyte non aqueux selon la revendication 4, dans lequel
ledit matériau d'électrode négative est un matériau d'au moins un type choisi parmi un oxyde métallique cristallin et un oxyde métallique amorphe qui permet le dopage/dédopage d'ions lithium.

6. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel
ledit mélange d'électrode positive contient un matériau d'électrode positive, un matériau conducteur et un liant.

7. Accumulateur secondaire à électrolyte non aqueux selon la revendication 6, dans lequel
ledit matériau d'électrode positive est un matériau d'au moins un type choisi parmi $LiMO_2$ (où M est l'un quelconque parmi Co, Ni, Mn, Fe, Al, V et Ti) et des composés de couche intermédiaire contenant chacun Li.

8. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel
ledit séparateur est constitué d'un matériau d'au moins un type choisi parmi le polyéthylène et le polypropylène.

9. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel
ledit collecteur d'électrode positive est constitué d'un matériau d'au moins un type choisi parmi l'aluminium, l'acier inoxydable et le nickel.

10. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel
ledit collecteur d'électrode négative est constitué d'un matériau d'au moins un type choisi parmi le cuivre, l'acier inoxydable et le nickel.

11. Accumulateur secondaire à électrolyte non aqueux selon la revendication 1, dans lequel

ledit accumulateur secondaire à électrolyte non aqueux contient un électrolyte non aqueux préparé par dissolution d'un électrolyte dans un solvant non aqueux, et
ledit solvant non aqueux est constitué d'un matériau d'au moins un type choisi parmi le carbonate de propylène, le carbonate d'éthylène, le 1,2-diméthoxyéthane, le 1,2-diéthoxyéthane, le carbonate de diéthyle, la γ-butyrolactone, le tétrahydrofurane, le 1,3-dioxolane, le 4-méthyl-1,3-dioxolane, le diéthyléther, le sulfolane, le méthylsulfolane, l'acétonitrile et le propionitrile.

12. Accumulateur secondaire à électrolyte non aqueux selon la revendication 11, dans lequel
ledit électrolyte est un matériau d'au moins un type choisi parmi $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiBF_4$, $LiB(C_6H_5)_4$, LiCl, LiBr, $LiSO_3CH_3$ et $LiSO_3CF_3$.

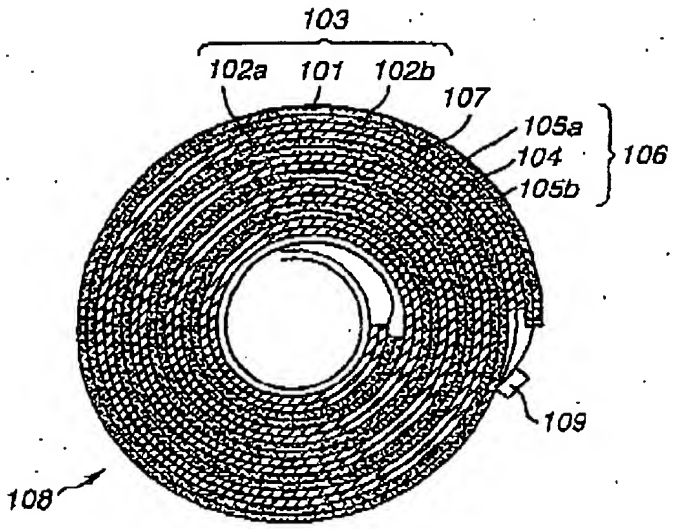

FIG.1

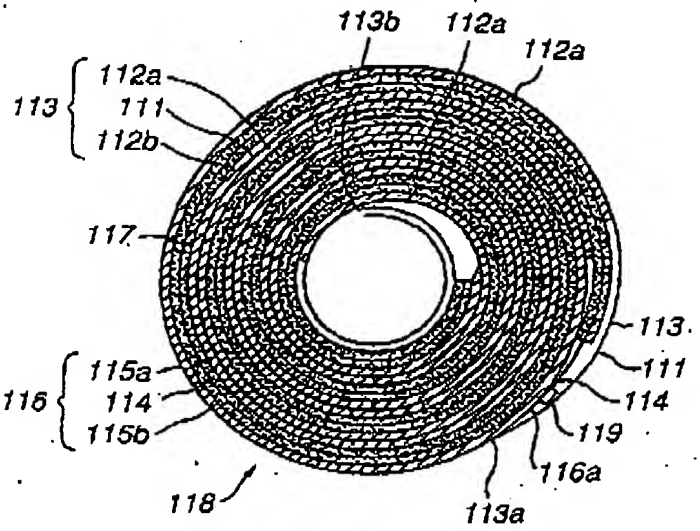
113b
112a
112a
112a
113
111
112b
117
113
111
114
119
116a
113a
116
115a
114
115b
118

FIG.2

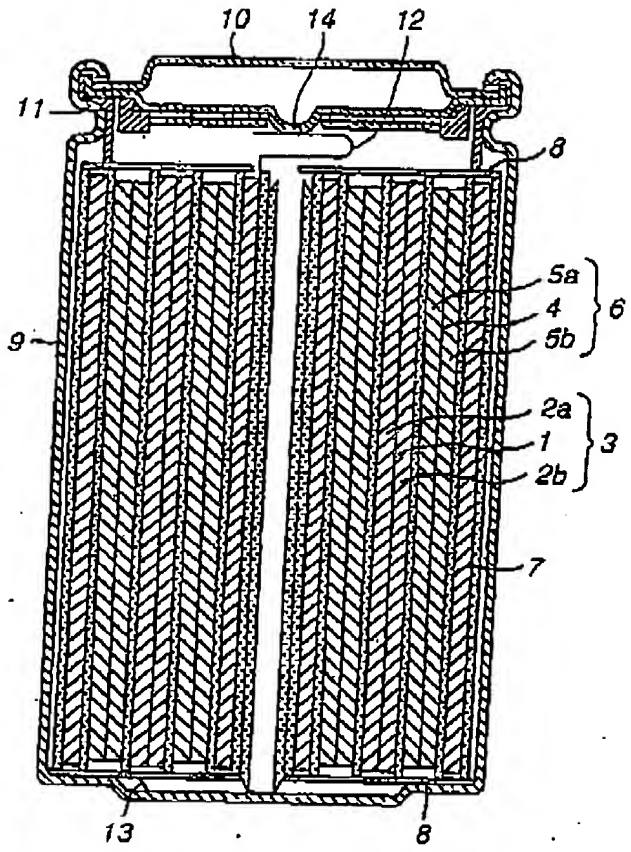

FIG.3

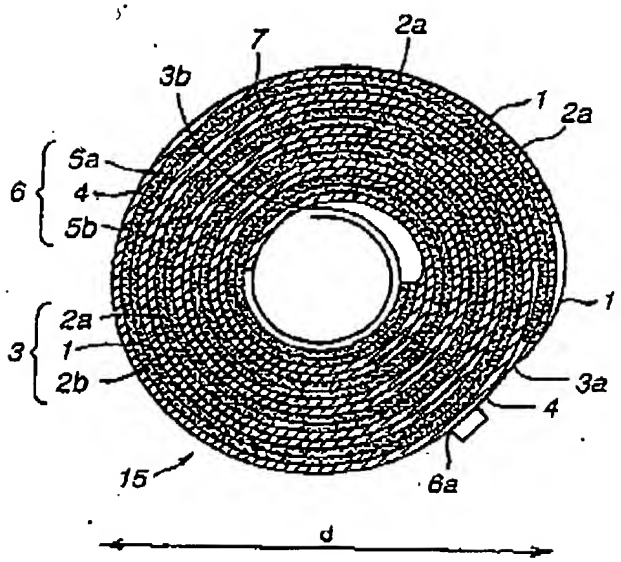

FIG.4

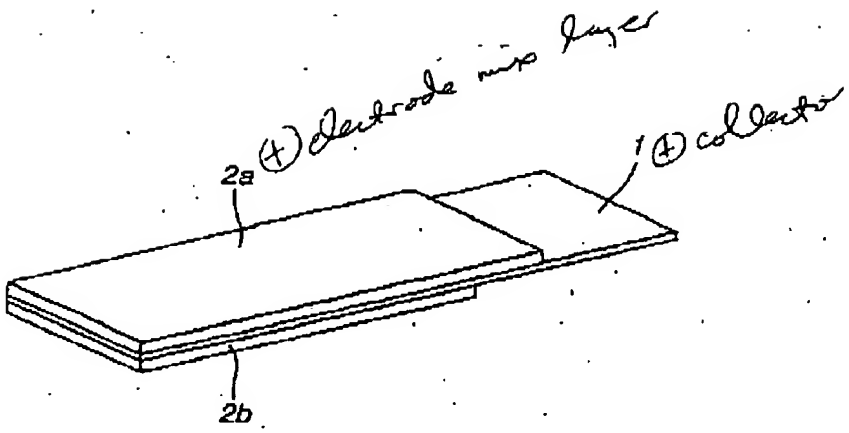

FIG.5